system - independent of the standard solution to prevent precipitation.

To ensure proper fertilization, leaf samples should be taken and sent in to the nearest testing lab for accurate assessment of nutrient levels. Adjustments were then made to encourage optimum plant health and productivity. Leaf analysis is a useful tool for assessing the nutritional status of the plants because the analysis determines actual nutrient levels in the plants. One of the greatest advantages of a leaf analysis is that deficiencies can be anticipated before they reduce plant growth. Contact your local County Cooperative Extension office for the location of the nearest testing facility.

# Considerations for Pest Management

While the plants are in the greenhouse, scouting for insect and disease should occur weekly and records kept as to what is found, when it is found, where it is found in the greenhouse and what measures are taken. These records will be helpful in following years as indications as to when to expect possible problems and how the problems were or were not successfully managed. It is possible to manage most insect pest populations with the use of cultural and biological controls and careful monitoring, so with proper care, no chemical pesticides may be required.

United States Environmental Protection Agency (USEPA) policy currently states that a pesticide can be used in a greenhouse as long as the target crop and organism are listed on the pesticide label, unless the label specifically restricts use in greenhouses. Pesticides cannot be used in the greenhouse if there is a specific greenhouse prohibition on the label. Biological and cultural controls often provide adequate pest control, but the use of a pesticide may be required for sudden and/or extreme pest outbreaks in which biological controls may not be effective quickly enough.

The predominant arthropod (includes insects and mites) pest problem is two-spotted spider mites. This pest can be managed by the use of certain predatory mites that are available from various biological pest control suppliers. Two-spotted spider mite populations can very quickly get out of control, and biological controls can take a while to bring pest populations under control, so careful, weekly scouting is essential. Predatory mite releases should begin in the greenhouse shortly after the leaves emerge from the buds, which will occur 3-4 weeks after the plants are brought into the greenhouse. Becoming educated in identifying both the insect pests and the beneficial, predatory insects is necessary to be able to differentiate between the “good bugs” and the “bad bugs”. Encouraging good air circulation, removing excess primocane growth, monitoring nutrient levels, and maintaining proper humidity and temperatures can significantly reduce pest pressure and create conditions favorable for biological control. (See section on individual pests.)

# Harvesting, Handling, and Transporting Fresh Fruit

Raspberries are a very perishable commodity, but steps can be taken to give them sufficient shelf life for marketing and consumption. By using proper management practices, many problems that can lead to unmarketable fruit can be avoided. Providing proper trellising and pruning will allow air and light movement through the canopy, which will discourage decay and disease organisms. Use drip irrigation to keep the fruit dry. This greatly reduces the amount of fungal infection on the fruit. Proper fertilization will keep plants from becoming stressed thus maintaining maximum fruit shelf life. Keeping insect pests at low levels will be less stressful to the plants and will also keep insect feeding on the fruit to a minimum. Just as important is the careful handling of the plants when moving them in and out of the greenhouse. Handle the plants as little as possible to minimize any damage to the canes. Even small wounds can become sites for fungal infection or cause damage to the vascular system that may not become apparent until the

canes leaf out and are not able to be supported by the damaged vascular system.

During the harvesting season, the fruit will ripen in stages, slowly at first, with a peak season in the middle, and then tapering off towards the end of the season. Fruit should be picked at the peak of ripeness and harvested directly into half-pint containers. The ripe fruit is very delicate and prone to damage if handled too much or too roughly. The fruit is generally ripe when the fruit releases from the core when very gently tugged. The fruit should not be picked if it takes too much effort to pull it off the core. If the fruit is to be transported a long distance or stored on display for a long period, the fruit can be harvested slightly unripe to avoid soft, mushy berries, but flavor will be sacrificed as the berries will not continue to ripen after they have been picked. Raspberries grown outdoors and shipped long distances tend to have very short shelf life and begin to decay very quickly, whereas greenhouse grown raspberries have been held in cold storage for as long as three weeks without showing any sign of fungal decay (although they will shrivel). The flavor intensity will decrease after less than a week, but since greenhouse grown raspberry fruit never become wet, the occurrence of fungal decay is much reduced in comparison with raspberries grown outdoors.

Since the fruit is so delicate and flavor quality decreases rather quickly, it is best to harvest and sell the fruit as quickly as possible. If access to a cold storage facility is available, placing each filled flat of harvested fruit immediately into the cooler will help maintain the high quality of fruit until delivery to a seller or market is possible. Harvest on a daily basis to maintain quality. In the first year of fruiting, each plant can produce about two half-pints (350g) of fruit. In following years, a harvest of up to as much as 20 half-pints per plant can be obtained in a two-month harvest window.

# Post-Harvest Plant Care

After the harvest season has ended, the fruiting canes can be completely cut off at the soil level and discarded, or in the case of primocane fruiting types, cut below the fruiting zone to promote additional bud break. After the risk of killing frosts has passed, the containers with the newly growing primocanes can be moved outdoors to grow for the summer, thus beginning the cycle all over again. These new primocanes may need to be cut back to a height of 6 ft (1.8 m) in order to remain manageable. ‘Tulameen’ is a very vigorous variety that can grow as much as 15 ft (4.5 m) per year, so pruning back the primocanes may be necessary. This also keeps the fruit harvested the next season within reach.

# Season Extension

By utilizing some of the following suggestions, it is possible to produce high quality raspberries during different times of the year as an alternative to relying on the brief, set time frame of the standard outdoor growing and chilling regime already described.

**• Staggered Production**

If a two-month early spring production period is too short, production can be lengthened using a variety of techniques. For floricane-fruiting varieties, several options exist.

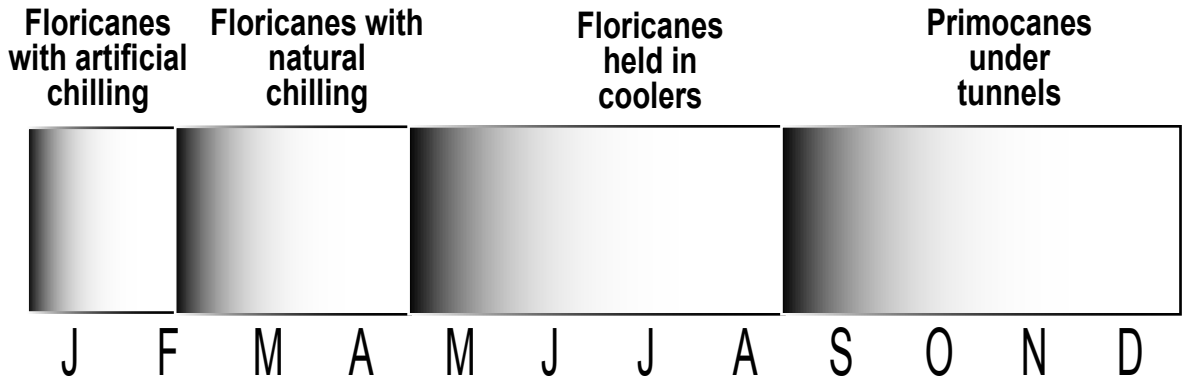
1) Hold plants in a cooler at 40°F (5°C) and bring them into the greenhouse 10 – 12 weeks before fruiting is desired. By staggering the time plants are brought into the greenhouse, production can be staggered as well. Plants can be held in a cooler from winter through summer, bringing them into a warm greenhouse as late as August or September. These plants will flower very quickly and fruit by late November. Yields tend to be lower, however, since canes would have been held a long period at cold temperatures.
2) Plants can be artificially chilled by moving them into 45°F (7°C) coolers as early as mid-August, with the leaves intact. After 10 weeks in coolers and 8 weeks in the greenhouse, plants will produce flowers by December and fruit by late January. In experiments at Cornell, defoliation of plants prior to chilling had no effect.
3) With a cooler, one can move plants into and out of the cooler during appropriate times (depending on day length) to provide chilling to primocanes, essentially mimicking winter and summer. A combination of cooler and greenhouses can be managed to eliminate outdoor growing, and establish a year around production season.

Dormant raspberry canes can be stored successfully for several months in a humid cooler maintained at about 34°F (1°C). Inside the cooler, plants should be watered when needed to maintain soil moisture. The longer plants are stored in the cooler, the shorter will be the time between bud break and fruiting because plants respond to warmer temperatures faster with more accumulated chilling.

These techniques open the possibility of significantly lengthening the fruiting season of floricane-fruiting greenhouse raspberries. Starting production earlier than February would have several advantages for growers who use the greenhouse for spring crops, such as bedding plants.

**• Primocane-fruiting**

Primocane-fruiting raspberries are most useful for producing fruit in late fall and early winter. Primocane-fruiting varieties will continue fruiting in the fall in a greenhouse or high tunnel, well past the time that production would normally cease outdoors due to cold weather, if they are moved inside the greenhouse by early September. Pinching primocanes will delay flowering and fruiting, shifting the crop to late in the fall. Experimentation will be required to determine the most effective pinching height



for a particular location. This practice has been successful under high plastic tunnels, as well as in greenhouses. Greenhouse growers may also have the option of holding primocane fruiting types in a cooler until late spring to delay the fall harvest. Bumble bees are used for pollination, and the fertility program is similar with 100 – 150 ppm N until fruiting, then 50 ppm N after flowering in a complete fertilizer formula.

A high tunnel structure with the sides rolled down and the ends closed

With a small amount of chilling, most primocane-fruiting varieties will produce a sequence of new canes that will fruit about 3 months after emergence. Once fruiting occurs, primocanes can be tipped several nodes below the fruited portion to stimulate new lateral production. This will allow raspberry fruit to be produced for a very long period of time on a single cane. However, chilling the canes will also promote bud break. With the primocane-fruiting varieties, yield per week may be less than with floricane-fruiting varieties, but the extended fruiting season for the primocane-fruiting varieties may equal overall total yield per plant. The extended fruiting season also means labor and maintenance costs will be higher, but having fresh raspberries available during the autumn when they are normally not available, will also allow a grower to charge a higher price for the fruit.

# High Tunnels

A high tunnel is a simple inexpensive structure similar to a greenhouse that provides a great deal of season extension versatility. High tunnels offer the opportunity for the grower to get a crop started early in the season, to stay in production later in the season, and, possibly to produce a crop such as greens through the winter. High tunnels also provide protection from rain and hail and can reduce disease and pest pressure. With good planning, variety selection, and close management, this low cost system can add another dimension to a raspberry operation. Under high tunnel systems, some floricane fruiting varieties have begun fruiting as early as the end of May, with the primocane fruiting beginning in early July. Depending on the weather conditions for the autumn season, it may be possible to extend the fall-fruiting crop into November, or even December in some climates. Temperatures under high tunnels are managed differently depending on the targeted window for harvest. For example, if floricane-fruiting raspberries are to be fruited in May or June, then shade cloth may be required beginning in May to reduce temperatures and reduce solar injury on fruit. If primocane-fruiting raspberries are to be fruited in November, then plastic may be removed entirely for the summer to reduce heat stress, and replaced once flowering begins.

In a high tunnel system, raspberries may be planted directly into the soil. The tunnel is large enough for the grower to plant, monitor and harvest the crop from inside the structure. The standard tunnel is 14 ft (4.25 m) wide, 96 ft (29.25 m) long, and 7.5 ft (2.3 m) tall at the center. However, these tunnels are too low for raspberries as the house will get too hot. Installing post extensions of 4 to 5 ft. will greatly improve air circulation and reduce heating. Tunnels wider than 14 ft are also more efficient

for managing raspberries. Tunnels should be no wider than 30 ft (9 m), for good cross ventilation and reduction of snow accumulation on the roof in the winter. Tunnels longer than 96 ft may pose a psychological barrier to pickers.

The Quonset frame consists of metal bows made by bending steel pipe or tubing. Potential stresses caused by the weight of snow or heavy wind must be considered.

Metal pipes are driven into the ground approximately 2 ft (0.6 m) deep and set every 4 ft (1.2 m) of the high tunnel length, providing support for the Quonset frame. The bows fit into the ground pipes and are attached by bolts. The ends of the structure can be plastic or wood on a wood stud frame, but should be removable to allow access for tillage equipment and to increase ventilation in the summer. The structure is typically covered with a single layer of 6-mil polyethylene with provisions for

A high tunnel structure with the sides rolled up
*Photo courtesy of the Fruit Growers News*

rolling up the sidewalls (some growers have reported better production with special light-diffusing plastic that increases light interception on lower laterals). The poly is secured onto a batten board on each side of the high tunnel about 5 ft (1.5 m) above the soil line. A vertical sidewall helps to keep rain out of the tunnel and when rolled up, provides ventilation. A pipe is then attached to the loose bottom end of the plastic along the length of the structure. A “T” handle on the end of the pipe is used to roll the plastic onto the pipe to open the sides. Cross ventilation is assisted by wind and has proven to be very efficient. See the suggested readings section at the end of this guide for links to more detailed information.

The key to successful use of the high tunnel is to spend the time laying out and preparing the site for construction. The better the tunnel is constructed, the easier the roll-up sides will work and the easier it will be to ventilate. During periods of cold weather the sides are lowered in the afternoon to hold heat and then raised in the morning to vent before temperatures inside get too high. The floor of the structure is covered with a layer of black weed barrier. This helps to raise the temperature inside the house, control weeds, prevents evaporation of soil moisture and allows excess water to drain. Excess moisture will raise humidity in the tunnel and may lead to disease problems. Humidity of the air will increase at night as the air cools down. Venting in the morning will allow drying of any condensed water. If raspberries will be planted directly in the soil, openings in the weed barrier can be created with a propane burner to keep edges from fraying.

High tunnels can actually reduce the incidence of some diseases, particularly if trickle-irrigation tubing is used. No water (rain or irrigation) gets onto the foliage to transport spores or otherwise encourage disease development.

The use of high tunnels does require an increase in both the level and the amount of management required to grow the crop. The sides must be raised and lowered to regulate temperature and humidity. Plants must be irrigated regularly and fertigated as needed. Unless supplemental heat is provided the tunnel may not be able to provide adequate protection to the plants after the November/December time frame depending on the year. Disease problems may occur in the protected environment; management of the environment is critical. Ventilation to avoid high temperatures or high humidity is very important. Unpredictable weather in spring and fall will make management intensive. Powdery

mildew and late yellow leaf rust are diseases that may occur with certain varieties under the high tunnel climate and should be monitored for closely.

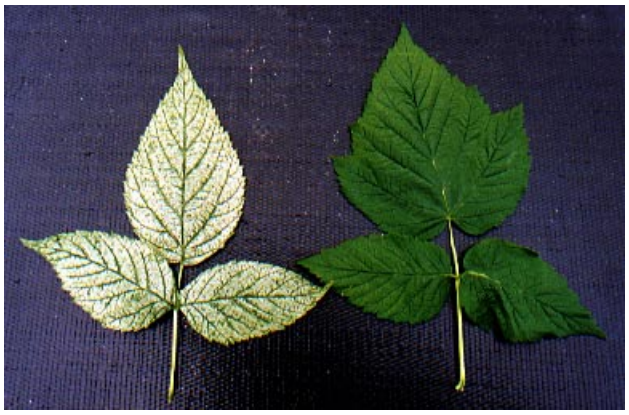
Insects will find the microclimate created for the plants to be favorable to their growth also. Without a doubt, scouting must begin when the plants are set out. The use of beneficials may be the most practical way to deal with some insect and mite problems. However, season extenders can actually be used as physical barriers to keep insects off the plants. For example, screening the sides to exclude insects, and the use of floating row covers that have the edges secured will prevent many insects from reaching the crop.

Bumble bees may be required to maximize production in the early and late part of the season when the sides are rolled up infrequently. The bees flying in and out of their boxes will stop off on the various flowers on their way in and out each day, which should provide adequate pollination. (Information provided by: <http://plasticulture.cas.psu.edu/>)

# Arthropod Pests

**Twospotted Spider Mites:** *Tetranycus urticae*
**Pest Biology**
Two-spotted spider mites are the most common species of free-living mites to cause damage to plants and are also probably the most significant pest for greenhouse raspberries. Two-spotted spider mites cause damage to raspberry plants in such a way that they weaken the plant by feeding on the undersides of the leaves. The spider mites use their piercing and sucking mouthparts to drain the nutritious fluids out of the tissue cells in the leaves. This act of feeding by the mites leads to one of the diagnostic symptoms of mite feeding, the yellow mottling that appears on the upper side of the leaves. A second diagnostic symptom of mite infestation is very fine webbing present on the underside of the leaves. In areas of major infestation, the webbing can also be seen bridging the space between leaves adjacent to each other. This webbing on the leaves protects the mites from enemies as well as chemical sprays. Round mite eggs, immatures, adults, cast skins and empty egg shells may be seen with a hand lens. If left unchecked, mite infestations can lead to extremely chlorotic leaves that are no longer functional to the plant and may abscise prematurely. Infestations will most often begin in the lower canopy of the plants and move upwards. Under extreme conditions this can lead to defoliation, stunting of plants and much reduced yields.

The twospotted spider mite


The leaf on the left shows severe damage from mite feeding

The adult female mite has eight legs, is about 0.5 mm (1/50th of an inch) long, and the color ranges from yellow/green to brown or becoming orange/red towards autumn before it overwinters. The male is much smaller, 0.3 mm (1/80th of an inch), and has a narrow body with a pointed abdomen. The signature two dark spots on the sides of the body are actually food contents visible through the insect's semi-transparent body. The body is oval with sparse spines. Immature mites may have only six legs, but otherwise resemble the adults, just smaller in size. The adult female can lay eggs at the

Webbing from the twospotted spider mites between severely damaged leaves

rate of 2 to 12 a day, thus able to produce over 100 eggs in less than a month's time.

Spider mites overwinter as adults in soil under leaf debris, on raspberry canes or on surrounding weeds. These mites are capable of producing numerous (10+) generations in a single growing season. Outdoors, female mites emerge late in the spring and begin laying eggs usually along midribs of younger leaves. If male populations are low and mating does not occur, the females will lay eggs that will produce only male offspring. Mites will generally survive for about 30 days under favorable conditions. Optimum mite development occurs around 30°C (86°F) and new generations occur every 8 days. New generations occur every 6 weeks under minimum development temperatures of 12°C (54°F). Egg-to-adult development time can range from 5 to 19 days depending on the temperature - longer for cool temperatures around 12°C (54°F) and less for temperatures of 24°C (75°F) or higher. In greenhouses the mites do not require a cold-induced hibernation period and new generations are produced continuously if left unchecked.

A female and male European mite

When the containers of raspberries have been placed near apple trees during the summer months, the following growing and fruiting season inside the greenhouse has shown infestations of European red mite, *Panonychus ulmi*. The European red mite looks quite different from the twospotted spider mite, and should not be a problem on greenhouse raspberries unless the containers have spent the summer outdoors near apple trees. There are biological controls available for European red mites if infestations do occur.

**• Cultural Control**

For raspberries grown outdoors, the two spotted spider mites become most active in the spring of the year and into early summer. In greenhouses spider mites are always a problem and need to be contended with at all times. For outdoor raspberries the mites can be controlled

with heavy irrigation or spraying the leaves with a heavy force of sprayed water, thus "washing" the mites off the leaves.

The two spotted spider mites tend to thrive in the warm and dry conditions often encountered in a greenhouse during the winter. Reducing the temperature at night to 12°C (55°F) and maintaining high humidity discourages mite outbreaks. Low humidity encourages mite feeding and at the same time is more distressing to affected plants. Maintaining humidity in the greenhouse above 70% but less than 90% will discourage mite feeding and also aid in hatching predator eggs. Removing leaves with "hot spots" of mite infestations will also help to reduce the mite populations. Use a hand lens to monitor for mites and release predators as soon as ***any*** mite-damaged leaves are found.

**• Chemical Control**
An application of a fine horticulture oil in the dormant season can be effective in managing populations by smothering the overwintering mites on the canes. Applications of horticulture oil during the hot, sunny part of the growing season is not recommended as the plant's leaves are sensitive to the oil and may become damaged due to phytotoxicity.

In most cases for raspberries grown outdoors, two-spotted spider mites are not usually a serious threat. Very few chemical options exist for mites. An organophosphate may temporarily suppress mite populations, but natural predators will also be reduced and lead to a later explosion of mite populations as they will be allowed to develop uninhibited by natural predators. Miticides are available for control, but tend to only control specific life stages. Therefore, repeated sprays will be necessary to control the following generations that hatch from the eggs left behind. Alternate the use of miticides with different modes of action so a build up of resistant populations is less likely to occur. Heavy infestations with webbing will require higher pressure to get the spray to go through the webbing and reach the mites. In all cases, adequate spray coverage on the bottom and upper leaf surface is required. One currently registered ovicide/miticide available for use on raspberries is Savey ® 50 DF (Hexythiazox). (Any mention of brand products in this production guide is provided for informational purposes only, and is not an endorsement of the product and/or its parent company. Please contact your local County Cooperative Extension representative for your specific state regulations and recommendations.)

**• Biological Control**
Natural predators including mites, lacewing larvae, lady beetle larvae (*Stethorus punctillum*), minute pirate bugs (*Orius* spp.), big-eyed bugs (*Geocoris* spp) and predatory thrips (*Scolothrips sexmaculatus*) will attack mites. Numerous mite predators in the Phytoseiidae family are commercially available including *Galendromus occidentalis*, *Phytoseiulus persimilis* (excellent at quickly reducing a light infestation), *Phytoseiulus longipes*, *Neoseiulus fallacis* (can be used as a preventative) and *Neoseiulus californicus* (can also be used as a preventative). Organophosphate-resistant strains of *P. persimilis* are commercially available. Some of these commercially available predatory mites do not overwinter in cold climates so reintroduction each season will be necessary.

Successful use of predatory mites in the greenhouse requires familiarity with the predators themselves. The predatory mite *Phytoseiulus persimilis* thrives in 20-30°C (68-86°F), humid (60-90% RH), semi-shaded environments. Adults are pear shaped, orange (sometimes tan or brown), and have long front legs. This fast moving mite will feed on all stages of the two-spotted spider mites and is able to move forward and backwards, whereas two-spotted spider mites only move forward. *P. persimilis* females lay approximately 50 eggs that are oval, slightly orange and twice as large as the eggs of the two-spotted spider mite. The eggs hatch in three days into six-legged non-feeding larvae. Within a couple of days the

larvae will molt into eight-legged nymphs and begin their feeding. *P. persimilis* can multiply twice as fast as prey and has a voracious appetite, able to devour 30 eggs, 24 young or 7 adult mites per day. Once P. persimilis eat all their prey, they will starve. Therefore, reinoculation is necessary if mite populations flare up. Best results are obtained if predatory mites are introduced into the greenhouse as soon as any signs of a mite infestation are found with careful monitoring, before massive mite infestations occur. It can take up to three weeks to attain control. A common reason for failure to control a mite outbreak with predators is releasing too few predators too late. Weekly releases for at least 3 weeks are needed.

*Neoseiulus fallacis* is another predatory mite that has been found to be very successful in reducing populations of the two-spotted spider mite. *N. fallacis* can be utilized as an inoculant against outbreaks and is able to survive lower temperatures, low numbers of prey, some pesticide applications, and is able to quickly bring down a light population of mites. A close relative, *Neoseiulus californicus*, is another predator that is slower in controlling outbreaks, but it can survive for a much longer time in the absence of prey. *N. californicus* is also adapted to a much wider range of environmental conditions and is able to survive and be highly successful in variable greenhouse conditions. A mixture of *N. californicus* and *P. persimilis* can be used for mite control as the *P. persimilis* will quickly reduce mite populations until *N. californicus* is able to build up and maintain low levels of mites for the long term.

Predators are usually shipped in sawdust or vermiculite and are sprinkled onto moistened raspberry leaves. To avoid higher chances of powdery mildew, it is best to spot-mist hot spots and then sprinkle on the predators rather than to wet down the entire canopy. Apply the predators in the mite infested hot spots so they will be able to quickly find their prey.

**Black Vine Weevil:** *Otiorhynchus sulcatus*
The black vine weevil is a dark snout beetle 8

to 11 millimeters long (0.25 to 0.4 inches), that will more likely been seen in the second year of production after bringing the plants into the greenhouse from outdoors. The adult weevils are nocturnal and will only be active at night. Feeding by the adults will first be seen as “notching” on the edge of leaves closest to the soil. The adults will feed on leaves of the newly developing lateral branches and may even excise the lateral, and during harvest they will feed on the ripening fruit making it unmarketable. The adults must feed on plant material for 21 to 45 days before they are ready to lay eggs. After the preoviposition period has passed, the females place several eggs each day into the soil or leaf litter. Adults may live 90 - 100 days and usually lay 200 eggs during this time. The eggs hatch in 2 - 3 weeks and the small, C-shaped, legless larvae feed on the plant rootlets. Root feeding may not kill the plants, but the feeding will interfere with nutrient and water uptake, thus negatively affecting the overall health and performance of the plants. The larvae grow slowly, molting 5 -6 times. By late fall outdoors, the larvae have matured and are about 5/8 inch long. The mature larvae enter a quiescent prepupal stage in an earthen

Weevil feeding on fruit

cell and pupate the following spring. A single generation occurs each year. In the warmth of a greenhouse, the larvae may pupate in January or February and the adults emerge in March or April. Control of the black vine weevil can be attained by various measures including a soil drench of entomopathogenic nematodes, *Steinernema* and *Heterorhabditis* spp., that will kill the larva, but the timing of the soil drench must coincide with the presence of the larva in the soil. In the warmth of a greenhouse, the larvae may pupate in January or February and the adults will emerge in March or April. The soil drench is ineffective on adult weevils. A manual method for managing adult weevils is placing a tarp on the floor and gently shaking the plants in the evening to dislodge the adults from the plant canopy and discarding them. The black vine weevil has a single generation per year. Avoid growing potted plants near weevil food sources, such as crabapples, yews, and other ornamental plants.

Weevil feeding on edges of leaves

**Raspberry Cane Borer, Rednecked Cane Borer and Crown Borer:**
*Oberea bimaculata, Agrilus ruficollis* and *Pennisetia marginata* (respectively)
Borer problems are occasional and will more likely occur in the second year of production after plants have been outdoors during the summer and are then brought into the greenhouses during the winter. They may also occur in the handle of bare-root planting stock. The presence of borers is evident by the wilting of the canes from the growing tips downward. Infestations occur during the summer when the plants are outside. The adults burrow holes in canes towards the tip, and then lay an egg inside. Cane borers produce a double ring of girdling marks approximately 2 cm (1 in) apart that go completely around the cane. The action of girdling the cane causes the growing tip to wilt and die, often breaking off later in the season. The egg will hatch into a larva that will feed on the tissue inside the cane and eventually bore its way down the cane, causing extensive damage. The cane will suffer weakening, wilting and perhaps death.

Cane borer larva feeding down the inside of a cane; indicative pair of girdle marks and entrance hole on cane; frass on leaves from feeding larva.

The only effective way to control these boring pests is to cut off the infected canes just below the girdle marks before the larva feeds down the cane. These boring pests tend to cycle in severity from year to year, so one year they may be in abundance and in other years they may almost completely absent. The best control measure is for the grower to keep a watchful eye for wilting symptoms of the plants, and check for girdle marks and swellings, and remove the infected portions as soon as possible.

Swelling in cane from feeding larva of the Crown Borer

Crown borer larva feeding inside cane near the root base

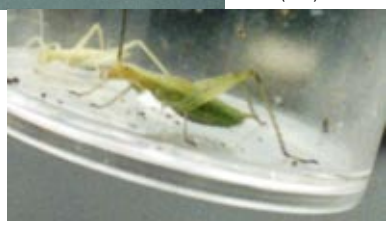
**Aphids:** *Amphorophora agathonica* and *Aphis rubicola*
Aphids tend not to be a significant problem in the greenhouse for red raspberries, but they do occur and can build in numbers quickly if left unchecked, particularly with black raspberries. Aphids occur on the new, succulent growth. The aphids feed on the major vein on the underside of leaves and may cause leaf curling. Aphids are the primary vectors of most bramble viruses. They can be effectively controlled with biological controls, such as lady bugs, lace wing larvae, and certain parasitic wasps. An application of a fine Horticulture oil will also reduce the numbers of aphids.

**Leaf Rollers** (Orange tortrix: *Argyrotaenia citrana*; Oblique-banded: *Choristoneura rosaceana*) and **Raspberry Sawflies** *Monophadnoides geniculatus*
Both leaf rollers and sawflies may be found in plants that have been brought into the greenhouse from outside. Leaf rollers have not been as much of a problem on greenhouse raspberries as sawflies. Sawfly larvae cause skeletonized leaves and leaf roller larvae roll up leaves which harbor the developing larvae. Sawflies can be abundant in certain years and quickly skeletonize many leaves in a very brief amount of time. The loss of many leaves will reduce the plant's ability to photosynthesize and sustain fruit production. If feeding is severe, fruit production and quality of fruit will be much reduced if not halted entirely, and there is the possibility of premature cane death. A couple of control options for sawflies is to prune out severely infested leaves with the hope that you will also remove the larvae, or simply pick off the larvae when found and destroy them.

Leaf roller larva exposed after unrolling leaf (above, left): sawfly larva and feeding damage on leaves

Some other possible pests that are less likely, yet possible, to be found on greenhouse raspberries includes: tree crickets, thrips, Japanese beetles, oriental beetles, and tarnished plant bug (*Lygus lineolaris*). These pests tend to be limited to certain locations, although when they occur, they can cause economic damage. Additional information regarding these pests can be found in the *Bramble Production Guide (Pritts and Handley, 1989; See pg.34).*

Tree crickets (below), signs of their damage on the cane and their eggs inside the cane (left.)



The "bronzing" effect due to the damage caused by the feeding of thrips

The adult tarnished plant bug